https://doi.org/10.7251/SSH2602247G
UDC: 612.766:57]:796.012.1
Original scientific paper
Originalni naučni rad

Effects of an adapted physical activity program integrated with applied behavior analysis in children and adolescents with autism spectrum disorder: a pilot study

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Abstract: *Adapted Physical Activity (APA) represents an area of growing interest within rehabilitation pathways for individuals with Autism Spectrum Disorder (ASD), as it enables the integration of motor, behavioural, and socio-relational dimensions within structured educational contexts. The present pilot study aims to examine the functional impact and ecological validity of an APA protocol integrated with the principles of Applied Behaviour Analysis (ABA). Twenty participants diagnosed with ASD, aged between 3 and 17 years, took part in the study and were involved in a 10-week training programme. Outcome assessment was carried out using a mixed observational design, integrating caregivers' perceptions collected through a post-intervention questionnaire and systematic observations conducted by ABA practitioners using a structured checklist. The results highlight an overall positive impact of the intervention, with significant improvements in motor functioning, active participation, and emotional and behavioural regulation. The findings suggest that APA integrated with ABA constitutes an ecologically valid and potentially effective intervention for promoting adaptive skills in individuals with ASD, confirming the central role of movement within integrated rehabilitation pathways.*
Keywords: *Emotional self-regulation, Social interaction, Engagement, Setting.*

Introduction

In recent decades, scientific and pedagogical interest in the inclusion of individuals with autism spectrum disorder (ASD) in educational, sport, and rehabilitation contexts has promoted the development of integrated and multidimensional intervention models aimed at enhancing global well-being and adaptive skills (Ceruso et al., 2024a,b). A substantial body of literature has shown that children and adolescents with ASD frequently present difficulties in motor coordination, action planning, and sensory modulation, with significant repercussions on communication, social skills, and functional autonomy (Fournier et al, 2010; Bhat et al, 2011; Taleb et al, 2021). These characteristics have progressively encouraged the adoption of an educational and rehabilitative perspective that recognizes the body not merely as an executive tool, but as a privileged space for cognitive, emotional, and relational mediation (D'Elia et al, 2020; Raiola et al., 2025). Within this theoretical framework, adapted physical activity (APA) assumes a central role as an educational and rehabilitative tool capable of integrating motor, cognitive, and socio-affective dimensions (Altavilla et al, 2022; Cascone et al, 2020). APA is not limited to compensating for physical difficulties but is configured as an intentional intervention aimed at supporting the development of executive functions, attention, emotional and behavioral regulation, and adaptive skills through the structuring of contexts and activities tailored to the functional characteristics of each individual (Pan, 2011; Bremer et al, 2016). The playful and motivational dimension of intervention represents a key element in fostering active engagement among individuals with ASD and in promoting meaningful and lasting learning processes, facilitating the transfer of acquired skills to everyday life contexts (D'Elia et al, 2023, Raiola et al, 2018). The effectiveness of APA is further enhanced when it is integrated with evidence-based methodologies, including Applied Behavior Analysis (ABA), which allows the training intervention to be structured according to principles of gradual progression, positive reinforcement, modeling, and generalization of learning (Lovaas, 1987; Cooper et al, 2007). In line with recent national guidelines, the integration of motor-based approaches and behavioral analysis represents a particularly relevant perspective, as it promotes self-regulation, active participation, and the development of social skills within structured settings characterized by predictability, routines, and clarity of demands (D'Isanto et al, 2022; Aliberti et al, 2025). Considering these premises, the present

pilot study aims to examine the ecological validity and functional impact of an APA protocol integrated with the ABA method and designed for children and adolescents with autism spectrum disorder (Altavilla, 2019). The objective is to evaluate the effects of the intervention on motor skills, adaptive abilities, and behaviors by adopting a dual analytical perspective that integrates parent and caregiver perceptions, collected through questionnaires, with systematic observations conducted by ABA practitioners using checklists focused on participation, self-regulation, and social interaction. This methodological approach makes it possible to combine subjective and observational dimensions, offering a more comprehensive and context-sensitive evaluation of intervention outcomes within a clinical and rehabilitative setting. Based on supporting scientific evidence, it is hypothesized that participation in an integrated specialized motor program may lead to improvements in behavioral self-regulation, accompanied by a reduction in stereotyped, oppositional, and frustration-related behaviors. An increase in active participation and interest in motor activity is also expected, along with greater confidence and competence in movement. Finally, it is hypothesized that structuring the intervention in small groups may foster the development of social skills, with an increase in imitative behaviors and spontaneous social and communicative interactions, as perceived by caregivers and observed by practitioners.

Purpose of the research

Overall, the study also aims to assess the sustainability and acceptability of the protocol, contributing to the definition of integrated, replicable intervention models that are consistent with the functional needs of individuals with ASD.

Materials and methods

Study participants

Children and adolescents (n = 20) with a diagnosis of autism spectrum disorder (ASD), recruited through the reference rehabilitation service. The sample was selected according to a convenience criterion, based on accessibility to treatment and the availability of families to participate in the study. Participants ranged in age from 3 to 17 years, with a higher representation of preschool and school-age children. With regard to the level of support according to DSM-5 classification, the sample was distributed among individuals with level 1 and level 2 support needs, both accounting for 40 percent of the sample, while the remaining 20 percent consisted of individuals with level 3 support needs. This distribution reflects the functional variability typically observed in clinical and rehabilitative settings and allows for a differentiated interpretation of the effects of the intervention. Inclusion criteria included the presence of an ASD diagnosis, active enrollment in the center's motor program, the ability to participate in the proposed activities with or without individualized support, and the availability of parents or legal guardians to provide informed consent for participation in the research. No specific inclusion criteria related to cognitive level, verbal language, or the presence of comorbidities were applied, in order to ensure greater adherence to real-world rehabilitative conditions. Participants presenting medical or physical conditions incompatible with the proposed physical activity, such as acute orthopedic or neurological disorders, were excluded from the study. Cases characterized by irregular attendance at the program, such as compromising intervention continuity and the observability of effects, were also excluded. Additional exclusion criteria included failure to obtain informed consent or interruption of treatment before completion of the observation period. With regard to ethical aspects and data protection, families were not required to provide detailed clinical documentation, such as medical certifications or diagnostic codes. In line with the principles of data minimization established by Regulation (EU) 2016/679 (GDPR) and current national legislation, only information regarding the level of support according to DSM-5 was collected, as it was considered sufficient and relevant to the exploratory aims of the study. Participation in other parallel physical or rehabilitative activities was recorded as a descriptive variable and did not constitute an exclusion criterion.

Study design

The present observational pilot study examined the ecological validity and functional impact of an APA protocol integrated with the principles of ABA within a real clinical and rehabilitative context. All participants took part in a standardized training program consisting of two weekly sessions lasting 60 minutes each, over a total period of 10 weeks. The intervention was conducted in small groups within a structured and predictable setting consistent

with ABA principles, in order to promote participation, behavioral regulation, and generalization of learning. The objective of the study was to examine the impact of the APA-ABA protocol on the functional profile of children and adolescents with autism spectrum disorder, considering both observable changes within the rehabilitative context and those perceived in daily life. To this end, a mixed-methods approach was adopted (D'Elia et al., 2022), integrating the perspective of parents and caregivers with systematic observations conducted by ABA practitioners involved in the treatment. Outcome evaluation was based, on the one hand, on the administration of a questionnaire addressed to parents and caregivers, aimed at detecting perceived changes in motor skills, self-regulation behaviors, and social abilities, and, on the other hand, on the use of an observational checklist completed by practitioners during sessions, designed to document the evolution of motor, regulatory, and social behaviors within the rehabilitative setting. The integration of observational data and caregiver-reported perceptions is consistent with the national guidelines of the Italian Society of Child and Adolescent Neuropsychiatry (SINPIA, 2022), which recommend a multidimensional approach to the assessment of adaptive and social skills in individuals with ASD. This methodological framework allows for capturing the complexity of functional changes by valuing both the objective dimension of observed behavior and the subjective dimension of family experience (Di Domenico et al., 2024; Esposito et al., 2024a). It should be noted that the absence of a pre-intervention assessment does not allow for a direct pre-post comparative analysis. However, given the exploratory and pilot nature of the study, the combined use of structured systematic observations and caregiver perceptions still allows for an ecologically valid evaluation of intervention effects, which is particularly relevant in real clinical settings. The duration of the program, set at 10 weeks, is also consistent with existing literature regarding the effectiveness of medium-term interventions for the promotion and stabilization of adaptive behavioral patterns in individuals with autism spectrum. The APA sessions were designed to promote the development of motor, socio-relational, and self-regulatory skills in children and adolescents with ASD. Each session lasted 60 minutes and was organized in small groups in order to ensure targeted intervention and optimal management of attention and social interactions. The proposed physical activities included exercises for hand-eye and gross motor coordination, static and dynamic balance exercises, circuits organized into stations with progressive tasks, imitative games, collaborative activities, and ball-passing games. Task complexity was adjusted according to participants' level of support, encouraging active participation and the gradual development of autonomy in task execution. From a pedagogical perspective, the sessions followed ABA-based protocols, including strategies such as graduated prompting, modeling, shaping, natural reinforcement, and token economy, which were used to support skill acquisition, attention maintenance, and generalization of learning (Esposito et al., 2024b). Each session was structured into three main phases: an initial welcoming and activation phase, including light stretching and imitation exercises; a central phase characterized by structured games, circuits, and group activities; and a final phase focused on cool-down, symbolic processing of activities, and positive reinforcement of observed behaviors. The setting was organized according to principles of predictability, with clear visual structuring, management of activity and break times, reduction of sensory overload, and visually accessible materials. Data collection was carried out at the end of the intervention using two structured assessment tools, aimed at capturing, on the one hand, caregiver perceptions of changes observed in the child and on the other hand, behavioral performance displayed during sessions through direct observation. The use of differentiated tools allowed for the integration of perceptual evaluation with observational assessment, enabling a more articulated interpretation of intervention outcomes. The first instrument was a post-intervention questionnaire administered to parents or caregivers. The questionnaire was designed to assess perceived benefits of the program across specific areas of child functioning and consisted of items organized into five domains: motor skills, behavior and self-regulation, social interaction, participation in activities, and overall perception of change. The structure of the questionnaire, the domains investigated, and the purpose of the items are reported in Table 1. Items related to motor skills investigated aspects such as movement control, coordination, and engagement in the proposed physical activities. The behavior and self-regulation domain included items related to the ability to maintain attention, manage transitions, and modulate behavioral responses. The social interaction domain explored modes of interaction with peers and adults and participation in group-based activities. The participation domain assessed the level of involvement and continuity of engagement during sessions. Finally, the overall perception domain allowed caregivers to express a global evaluation of changes observed following the intervention.

Table 1. *Structure of the questionnaire for caregivers*

Area of investigation	Description of the items	Purpose
Motor skills	Movement control, coordination, involvement in physical activities	Detect perceived changes in motor skills
Behavior and self-regulation	Attention, management of transitions, regulation of behavioral responses	Assess self-regulation ability
Social skills	Interaction with peers and adults, participation in group activities	Analyze social skills
Participation	Involvement and continuity of engagement during sessions	Estimate the level of engagement
General perception	Overall evaluation of observed changes	Identify the caregivers' overall judgment

The second instrument consisted of an observational checklist completed by the practitioners during the sessions. The checklist is structured into items divided into four observation areas, as illustrated in Table 2, and is aimed at the systematic assessment of the child's behavioral performance in an ecological setting. Observations focus on the level of participation in activities, self-regulation abilities, patterns of social interaction, and responses to sensory stimuli present in the environment. The checklist was completed by experienced staff with ABA training, based on direct observations conducted during the sessions, in order to ensure consistency and reliability in behavioral assessment.

Table 2. *Structure of the practitioners' observational checklist*

Observation area	Observed behaviors	Assessment method
Participation and motivation	Active involvement and task persistence	Direct observation
Self-regulation and behavior	Management of behavior and waiting	Direct observation
Social skills and communication	Interaction, cooperation, and response to instructions	Direct observation
Sensory processing	Response and adaptation to sensory stimuli	Direct observation

Both instruments adopt a five-point Likert rating scale, with values ranging from 1 to 5, where 1 indicates "Not observed/Not applicable" and 5 indicates "Always." The use of the same rating scale for both the questionnaire and the checklist allowed for greater uniformity in data interpretation and facilitated descriptive comparisons between caregivers' evaluations and those recorded by practitioners. Although the instruments used in the present study were developed ad hoc to address the specific aims of the intervention, the investigated areas and reference constructs are consistent with those explored by validated instruments reported in the literature. In particular, the assessment of adaptive behaviors, self-regulation, and social skills is aligned with standardized measures such as the Child Behavior Checklist (Achenbach & Ruffle, 2000) and the Adaptive Behavior Assessment System (Oakland & Harrison, 2011), while the evaluation of social competencies and relational difficulties is consistent with the constructs assessed by the Social Responsiveness Scale (Bruni, 2014). Similarly, the dimensions related to self-regulation and sensory responsiveness are in line with specific tools developed for the observation of these aspects in developmental age (Altavilla et al., 2024; D'Isanto et al., 2024). These theoretical and psychometric references guided the definition of the items in order to ensure adequate content validity of the instruments used. Data collected through the caregiver questionnaire and the practitioners' checklist were analyzed using descriptive statistics. For each item, the arithmetic mean, standard deviation, and minimum and maximum values were calculated to describe the distribution of responses across the different areas of investigation. A descriptive comparison was also conducted between the scores obtained from the questionnaire and those derived from the observational checklist, in order to explore the consistency between caregivers' subjective perceptions and the observational evaluation of performance during the sessions. With regard to ethical aspects, the study was conducted in accordance with principles for the protection of participants. Prior to the start of the program, all caregivers provided informed consent to participate after receiving clear information about the aims of the study, the methods of data collection and processing, and the guarantee of anonymity. Each participant was assigned an anonymous alphanumeric code, used exclusively for data linkage purposes. Data were stored in a secure manner for a maximum period of twelve months and subsequently deleted, in compliance with current regulations on personal data protection.

Results

Data analysis highlights an overall positive impact of APA across the investigated areas, with particularly relevant results in the motor, participation, and behavioral self-regulation domains. The evaluations provided by caregivers and the observations conducted by practitioners show good convergence, strengthening the interpretation of the findings. With regard to the physical domain, caregivers report a positive perception of the changes observed in children at the end of the program. As shown in Table 3, interest in movement is high (M = 4.15), as is the perception of increased physical confidence (M = 4.10). Particularly noteworthy is the result related to the generalization of physical behavior, with the item "Is more active also outside the center" showing the highest mean within the area (M = 4.25). These findings suggest that the intervention affected not only motor skills per se, but also motivation and the propensity for physical activity in contexts other than the structured setting.

Table 3. *Caregivers perceived benefits in the physical domain*

Item	M	SD	Min	Max
Shows interest in movement	4.15	1.21	3	5
Accepts initiating the activity	3.90	1.25	3	5
Moves with greater confidence	4.10	1.04	3	5
Follows the practitioner's instructions	4.15	0.59	3	5
Is more active also outside the center	4.25	1.04	3	5

Practitioners' observations confirm these results, highlighting high levels of participation and motivation during the sessions. As reported in Table 4, children enter the activity space without opposition (M = 4.10), accept initiating the activity (M = 4.10), and maintain attention throughout the duration of the proposed tasks (M = 4.30). These data suggest that the structured APA setting facilitates activity initiation and supports sustained engagement over time.

Table 4. *Practitioners' observations on participation.*

Item	M	SD	Min	Max
Enters the space without opposition	4.10	0.44	3	5
Accepts initiating the activity	4.10	0.30	4	5
Maintains attention	4.30	0.50	3	5
Completes the activity	4.19	0.51	3	5

Regarding sensory responsiveness, practitioners reported good acceptance of environmental stimuli and materials used during activities. The item related to acceptance of different materials showed a mean of M = 4.05, while marked discomfort in response to noise or tactile contact was limited. These findings are consistent with the adopted environmental structure, characterized by controlled progression of stimuli and continuous educational mediation. Turning to behavioral and self-regulation outcomes, the most relevant results of the entire study emerge. Caregivers report a marked improvement in emotional regulation, with the item "Calmer after the activity" reaching the highest overall mean (M = 4.60), accompanied by a low standard deviation (SD = 0.60), indicating high response homogeneity. Improvements in frustration management and reductions in oppositional behaviors were also rated positively (M = 4.05 for both items).

Table 5. *Caregivers' perceived effects on behavior and self-regulation*

Item	M	SD	Min	Max
Calmer after the activity	4.60	0.60	3	5
Better compliance with rules	4.20	1.23	3	5
Shows less opposition	4.05	1.09	3	5
Manages frustration better	4.05	0.60	3	5

Practitioners' observations are consistent with these perceptions. Compliance with basic rules (stop, turn-taking, waiting) and tolerance of task difficulty both show a mean of M = 4.21, while reductions in oppositional behaviors observed during sessions reach M = 4.05. These findings indicate that APA appears to promote greater behavioral stability and improved management of task demands. With respect to social functioning, the data show more evident improvements in indirect interactions and those mediated by motor tasks. Practitioners report good levels of participation in dyadic or group activities (M = 4.05) and high levels of motor imitation (M = 4.35), while initiative toward peers reaches a mean of M = 4.00. From the caregivers' perspective, improvements are observed in the ability to observe peers to understand what to do (M = 4.05), whereas direct imitation of movements is slightly lower (M = 3.55). The item related to direct communication ("Communicates more during/after the activity") shows the lowest mean within this domain (M = 3.40), suggesting that observed social improvements do not automatically translate into an equivalent increase in verbal communication. Finally, caregivers' overall perception of the intervention is extremely positive. Perceived usefulness of the program, overall satisfaction, and organizational satisfaction all reach a mean of M = 4.50, with responses concentrated at the upper end of the scale. Qualitative analysis of open-ended responses confirms these findings, highlighting perceived benefits particularly in the physical and emotional regulation domains. In parallel, practitioners' qualitative observations indicate that approximately 80% of participants show greater task tolerance, increased spontaneous social interaction, and improved acceptance of turn-taking with peers.

Discussion

The results of the pilot study confirm that APA, when integrated with ABA principles, has a positive and cross-cutting impact on motor, behavioral, and socio-relational dimensions in children and adolescents with ASD. The most evident effect concerns emotional self-regulation and behavioral management, with particular emphasis on the reduction of post-activity agitation, suggesting that APA may act as an emotional stabilizer and facilitate stress level regulation within structured contexts (Anderson-Hanley et al, 2011; Penedo & Dahn, 2005). These findings are especially relevant for profiles characterized by sensory atypicalities, in which emotional dysregulation often underlies oppositional behaviors (Williams et al, 2021; Esposito, 2024). The intervention also promoted active participation and motivation, as highlighted by practitioner observations and caregiver perceptions. This supports the hypothesis that a predictable and structured setting, combined with ABA strategies such as contingent reinforcement, graduated prompting, modeling, and task analysis, facilitates not only the acquisition of complex motor skills, but also attention maintenance, tolerance of challenges, and generalization of adaptive behaviors (Hansen et al, 2022). The evidence suggests that APA can create an enabling educational context in which activity structuring and controlled stimulus progression allow participants to consolidate motor, social, and self-regulatory skills in a consistent and reproducible manner. From a socio-relational perspective, the most significant improvements emerged in task-mediated interactions, motor imitation, and joint attention, while direct verbal communication showed more gradual progress. This phenomenon confirms the role of embodied interaction as a privileged channel for the development of social skills in individuals with ASD, highlighting how shared movement and motor synchrony may represent relational modalities that are less dependent on linguistic mediation (Gallese, 2001; Rizzolatti & Sinigaglia, 2010). Caregiver reports support these findings, indicating perceived benefits not only in motor skills and emotional regulation, but also in socialization and participation in non-sport contexts, thereby confirming the generalization of adaptive behaviors and the effectiveness of the ABA approach. While acknowledging the importance of these results, the methodological limitations of the study must be considered. The absence of a pre-intervention assessment does not allow for a formal pre-post comparison, limiting the ability to establish causal relationships between the intervention and observed changes. The small sample size and pilot nature of the study further limit the generalizability of the findings to other ASD populations. The use of ad hoc instruments, although consistent with standardized scales and appropriate for the clinical context, may reduce comparability with previous studies. Finally, post-intervention data collection based on caregiver subjective perceptions and practitioner observations may introduce evaluative bias. However, convergence between these two sources increases the reliability of the collected evidence. To further enhance effects on verbal communication, it may be useful to integrate specific protocols of Augmentative and Alternative Communication (AAC). Overall, these findings support the consideration of APA not as an ancillary activity, but as a central component of continuous rehabilitation and habilitation pathways for individuals with ASD.

Conclusion

This pilot study confirms that APA, when integrated with ABA strategies, promotes significant improvements in emotional regulation, management of oppositional behaviors, and participation in physical activities, with generalization of adaptive behaviors also occurring in non-sport contexts. Social improvements emerge primarily in task-mediated interactions and motor imitation, while direct verbal communication shows more gradual gains. Although limited by the absence of a pre-intervention assessment, the small sample size, and the use of ad hoc instruments, the study suggests that APA represents a central habilitative intervention within rehabilitation pathways for individuals with ASD and should be integrated with specific communication-focused strategies in order to maximize overall effectiveness.

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Primljen: 05. mart 2026. / Received: March 05, 2026
Prihvaćen: 02. jun 2026 / Accepted: June 02, 2026

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